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A HOSPITAL ADMISSION SYSTEM BASED ON NURSING WORK LOAD

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ABSTRACT

This paper presents the hospital admission systems based on (i) patient census and (ii) nursing work load. It is shown that nursing costs are lower under the work load-based system than under the patient-based one.

1. INTRODUCTION

Hospital admission involves staying at a hospital for at least one night or more. Staying in the hospital overnight is done because the individual is too sick to stay at home, requires 24-hour nursing care, and/or is receiving medications and undergoing tests and/or surgery that can only be performed in the hospital setting. An individual may be admitted to the hospital for a positive experience, such as having a baby, or because they are undergoing an elective surgery or procedure, or because they are being admitted through the emergency department. Being admitted through the emergency department is the most stressful of these circumstances because the event is unexpected and may be a major life crisis. Before the person is taken to their room, admitting procedures are performed. The person's personal data is recorded and entered into the hospital's computer system. This data may include: name, address, home and work telephone number, date of birth, place of employment, occupation ,emergency contact information, or the names and telephone numbers of those individuals the hospital should contact if the person being admitted needs emergency care or their condition worsens significantly, insurance coverage, reason for hospitalization, allergies to medications or foods, religious preference, including whether or not one wishes a clergy member to visit .

There may be several forms to fill out. One form may be a detailed medical and medication history. This history will include past hospitalizations and surgeries. Having this information readily available will make the process move faster, and can allow a family member or friend who is accompanying the person to help fill out the forms more easily. The hospital may ask if there are any advance directives. This refers to forms that have been filled out indicating what medical decisions one wants others to make on their behalf. One form is called a living will and clearly tells which specific resuscitation efforts the person does or does not want to have performed on them in order to save or extend their life. Another form may be a durable power to attorney. This is a form stating whom the patient wishes to make medical decisions for them if they themselves are unable to do so, such as if they are in a coma. Some hospitals have blank forms that the individual can use to make these designations, others may just ask if the forms have been filled out, and if so to add a copy of them into the person's medical record. They are considered legally binding, and an attorney can assist in filling them out. During the time spent in admitting, a plastic bracelet will be placed on the person's wrist with their name, age, date of birth, room number, and medical record number on it. A separate bracelet is added that lists allergies. Forms are completed and signed, so that the patient is giving full consent to have the hospital personnel take care of them while they are in the hospital during that particular hospital stay. Subsequent hospital stays require new consent forms.

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Once all the admitting information has been completed, the next step is usually being taken to one's room. Most people stay in a semi-private room, which means that there are two people to a room. In some circumstances, a person's medical condition may require staying in a private room. If there are private rooms available, and the individual is willing to pay the extra cost (insurance companies generally only cover the cost of a semi-private room), it may be possible to have a private room. Most hospital rooms are set up so that one bed is closer to the door, and the other is next to a window. There are curtains that can be drawn completely around the bed so that some degree of privacy is possible. Once taken to a room, the nurse taking care of the patient will go over the medical and medication history, and orient the person to the room. This means that they will explain how to adjust bed height, how to use the nurse call button, show where the bathroom is located, and explain how to use the bedside telephone and television. The cost for the telephone and television are not usually covered by insurance. There is usually a calendar in the room, to help the patient keep track of the date, as it can be disorienting to be in an unfamiliar place, especially over several days or weeks. There may be limitations on using the bathroom, if the person's doctor feels that the patient's condition is such that they should not get out of bed. These kinds of decisions are made with the person's safety and medical condition in mind. If the person is not thinking clearly, perhaps because of some medication they are receiving, the side rails of the bed may be put up, to prevent falling out of bed. The nurse will review the doctor's orders, such as what tests have been scheduled, whether or not they can get out of bed for the bathroom or to walk around the unit, what medications they will be getting, and whether or not there are restrictions on what they can eat. The hospital will supply towels, sheets, and blankets, but some people like to bring something personal with them from home. Because of the risk of infections being transferred from one patient to another, one may prefer to leave things at home. If one does choose to bring in something personal, it should be washed with warm or hot water and soap to make sure that germs are not brought home from the hospital.

Sometimes when people are admitted to the hospital they need extremely close observation that can only be given in specialized care called an intensive care unit. Because of the severity of their condition, visiting hours are more restricted than in the regular rooms. It may be that only one or two people can visit at a time, and only for a few minutes at a time. Once the person's condition improves, they may then be transferred to a room with a less rigid visitation policy. If an individual has a surgical procedure performed, they will spend a few hours in a recovery area. This is to make sure that the person's condition is stable before returning to the regular room. Visiting is limited in the recovery area, and the person may spend most of the time sleeping, as the effects of the surgical anesthesia wear off.

If the person entering the hospital is a child, the parents or guardian will fill out the hospital forms. Most hospitals allow parents and guardians to stay overnight in the hospital with the child, and to be with them 24 hours a day. Many hospitals have special areas for children to play in, and even areas in which they do not have anything done to them which is painful, so they can completely relax. Barnum *et al.* [1993] have developed a strategy of public hospitals in developing countries. Berman [1982] has developed a selective a primary health care. Boldy[1976] has made a review of application of mathematical programming to tactical and strategic health and social services problems. Evans *et al.* [1995] have developed an application of economic evaluation techniques in the health sector. Flessa [2001] has developed a Ressourcenallokation and Zeitpraferenz in der Geundheitsdistriktplanung von Entwicklungslandern, Gish [1982] has developed a selective primary health care in social science and medicines. Hanmer *et al.* [1999] have developed a poverty and human development in the years 2015.Heidenberger [1996] has a developed a model in Strategic investment in preventive health care quantitative modeling for programme selection and resource allocation. Murray *et al.* [1994] have developed a technical basis for disability adjusted life years. Segall [1983] has developed a planning and politics of resource allocation for primary care and a promotion of meaningful national policy. Stenson *et al.* [1994] have developed a program on what future of WHO.

2. DATA OF THE PROBLEM

To illustrate the model’s use, we consider a 50 bed-nursing ward of Nagarjuna Hospital located in Hyderabad. We assume that there are five kinds of patients, requiring 1, 2, 3, 4 or 5 care units of work per day, where the fundamental work unit is taken to be 2 hours of nursing effort. Tables 1 and 2 give the distributions of patient requirements and urgent arrivals, respectively. We set the parameter of the Bernoulli discharge process at p = 0.15, which gives a mean length of stay of 1 / p = 6.67 days.

TABLE 1

Five Patient Populations

m	1	2	3	4	5	μ_g	σ_g
$g_1(m)$	0.75	0.00	0.00	0.00	0.25	2.0	1.7
$g_2(m)$	0.50	0.25	0.125	0.00	0.125	2.0	1.3
$g_3(m)$	0.35	0.40	0.15	0.08	0.02	2.0	1.0
$g_4(m)$	0.15	0.70	0.15	0.00	0.00	2.0	0.6
$g_5(m)$	0.00	1.00	0.00	0.00	0.125	2.0	0.0

TABLE 2
Distribution of Arriving Urgent Patients

j	0	1	2	3	4	5	6	7	8	9	10
f(j)	0.02	0.04	0.06	0.08	0.12	0.16	0.16	0.14	0.10	0.08	0.4

3. A MODEL OF THE HOSPITAL ADMISSION SYSTEM

A discrete time, discrete state model is used to describe the necessary dynamics. We assume that there is a fundamental unit of nursing effort [measured in hours of care per day], such that the needs of each patient can be expressed as an integral number of these care units. If the nursing wad is already at capacity, then the arriving urgent patients are assigned to another ward. It is also assumed that the right combination of nonurgent patients can also be found to bring the load just up to the minimum desired level. The discharge date of each patient is determined by a sequence of independent Bernoulli trails.

To formalize the model we introduce the following definitions, where the notation "units" refers to patients under Policy I and work under Policy II.

f(j) = Prob (*j* urgent units arrive in one day),
g(m) = Prob (patient requires *m* care units of work per day),
q(k/r) = Prob (*k* units leave in one day given that there were r units in service),
Pn = Steady state probability of having *n* units in service,
Tu = Steady state probability of turning *u* arriving units away in one day,
L = Number of units in system below which nonurgent patients are admitted,
M = Maximum number of units that can be accommodated by the nursing ward.

The state of the system is defined as the number of units in service (patients or work, as the case may be). In the steady state, the probability of making a transition out of a state is equal to the probability of making a transition into the state.

Thus the steady" state conditions are:

$$Pn = 0, \quad n < L, \tag{1}$$

$$Pn = \sum_{r=L}^{M} P_r \left[\sum_{k=r-L}^{r} (q(k/r)\,.\sum_{j=0}^{L-r+k} f(j))\right], n = L, \tag{2}$$

$$Pn = \sum_{r=L}^{M} P_r \left[\sum_{k=0}^{r} (q(k/r).\, f(n-r+k))\right], L < n < M \tag{3}$$

$$Pn = \sum_{r=L}^{M} P_r \left[\sum_{k=0}^{r} (q(k/r)\,.\sum_{j=M-r+k}^{\infty} f(j))\right], n = M, \tag{4}$$

$$Pn = 0, n > M, \tag{5}$$

Equations(2)-(4) are M – L + 1 linear equations in as many unknowns and to solve them for the steady state distribution of the number of units in service we require:

$$\sum_{n=L}^{M} P_n = 1 \tag{6}$$

The steady state probability of refusing admission to *u* urgent arrivals in any one day is the probability of being in state *r* times the probability that there are $M + u - r$ more arrivals than discharges, summed over all *r*, That is,

$$T_n = \sum_{r}^{M} P_r \left|\sum_{k=0}^{r} ((q(k/r).\, f(M+u-r+k))\right|, \ u = 1,2,3 \ldots\ldots \text{and} \tag{7}$$

$$T_0 = 1 - \sum_{u=1}^{\infty} T_u \tag{8}$$

Equations (1) – (8) are used to model both policies. They are first solved for policy I to find the steady state distribution of census. For this policy L and M are set equal to the minimum and maximum number of beds, respectively. The input distribution under this policy, f(.), gives the number of arriving urgent patients each day, and the discharge distribution, q(./r), gives the number of patients that are discharged given that the census was r. The resultant steady distribution of census is then used in compound sampling with the patient requirements distribution, g(.), to determine the steady state distribution of work under policy I. The moments of this latter distribution are

$$\mu_w = \mu_c \mu_g, \tag{9}$$

$$\sigma_\omega^2 = \mu_c \sigma_g^2 + \sigma_c^2 \mu_g^2, \tag{10}$$

where the subscripts refer to the following random variables:
w = work load,
c = census
μ = individual patient requirements

The model is then solved for Policy II, trying several values for the work load limits, L and *M*, until the right combination is found such that on the average the two policies treat the same urgent and nonurgent work loads. The input distribution for this case, f(.), gives the number of urgent work units that arrive each day and is found by compound sampling from the distributions of urgent patient arrivals and individual patient requirements. The discharge distribution under Policy II, q(./r), gives the amount of the work discharged, given that the work load was *r*. In most applications [where the total nursing work load is large compared to the amount of work discharged in one day], it can be approximated by the normal distribution with moments directly proportional to the total work load *r*.For this approximation, the proportionality constant is found by equating the moments of discharged work under Policies I and II when the two policies are in slates L and M. The output of the model under Policy II gives the steady state distribution of work load directly.

4. RESULT AND ANALYSIS

The results of the study are given in Table 3. The subscript *T* in this table refers to turned away units. The patient requirements distribution is representative of many medical-surgical populations. The Table 3 shows that the average census is 44.8 patients, which gives a mean occupancy of 90 percent. Simple calculations reveal that about 80 percent of the work is due to the urgent patients. The statistics are typical of the operation of many nursing units.

TABLE 3
Summary of Two Case Studies

Policy I			Policy II		
L	=	43 Patients	L	=	80 works units
M	=	50 Patients	M	=	104 work units
μ_c	=	44.8 Patients			
σ_c	=	2.3 Patients			
μ_ω	=	90.1 work units	μ_ω	=	90.5 work units
σ_ω	=	8.1 work units	σ_ω	=	5.6 work units
μ_T	=	0.1 patients per day			
σ_T	=	0.2 work units per day	μ_T	=	0.2 work units per day

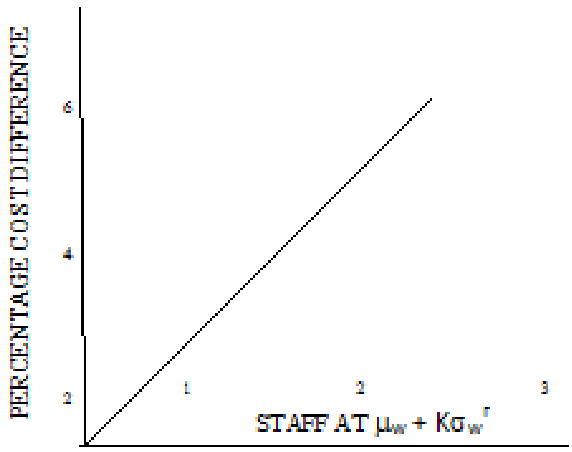

Figure-1: Percentage Cost Comparison of Policies I and II

Since these results assume the same typical population, we use them to compare the cost differences of Policies I and II. Assume that it is desired to staff at a level $\mu_\omega + k\sigma_\omega$. The percentage difference of the staffing costs under the two policies, δ, is given by:

$$\delta = \frac{\mu_1 + k\sigma_1 - (\mu_2 + k\sigma_2)}{\mu_1 + k\sigma_1} \text{ x } 100 \quad (11)$$

Here the subscripts 1 and 2 refer to the work load distributions under policies I and II, respectively. Since $\mu_1 \sim \mu_2$, we have

$$\delta = \frac{K(\sigma_1 - \sigma_2)}{\mu_1 + k\sigma_1} \text{ x } 100, \quad (12)$$

and substituting the values from Table 2.3 we find

$$\delta = \frac{25\text{ K}}{90.4 + 80.1k} \text{ x } 100 \quad (13)$$

The graph of equation (13) is presented in Figure 1, where it is shown that policy II is less costly than Policy I. For example, if it is desired to staff between $\mu_\omega + 2\sigma_\omega$ and $\mu_\omega + 3\sigma_\omega$ then savings of 4.7 to 6.5 per cent are achieved by using policy II.

In order to place these savings in the proper perspective, we examine the situation of no control at all. The uncontrolled case is modeled by modifying the input distribution to account for the nonurgent arrivals and by setting *L* and *M* so that essentially no patients are turned away or are admitted from the waiting list. Under these modifications it is found that the mean and standard deviation of the uncontrolled work load are 90.4 and 13.7 work units, respectively.

5. CONCLUSION

Hospital admission involves staying at the hospitals for at least one night or more. Staying in the hospitals over night is done because individuals is too sick to stay at home requires 24 hours nursing care and is receiving medications and undergoing tests and surgery that can only be performed in the hospitals setting. This paper describes the hospital administration system board on patients senses and nursing work load.

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